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ABSTRACT

This is a progress report of an individualized three-year science course for use in the senior high school. The course integrates biology, chemistry, and physics with smaller amounts of astronomy, geology, meteorology, oceanography and space exploration. The course is currently in the second year of tryout in the Elk River, Minnesota, school district. The course specifically presents material in small packages called Mini-units. Each mini-unit includes an objective specifying the behavioral change that the student is to achieve and suggested activities, experiments, readings, problems, visual aids and tests to help in the achievement. The report includes a review of the project history, the philosophy and goals, materials, operational modes, evaluation procedures, expenditures and project significance. Subjective evidence to show the success of the project is claimed. Objective evidence is in the process of being collected through a testing program. The appendix contains (1) an abstract of the progress report, (2) a progress report form for mini-units, (3) a progress report form for work not directly related to mini-units, (4) a cumulative record for a student, and (5) a sheet stating the criteria for award of grades. This work was prepared under an ESEA Title III contract. (LC)

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A PROGRESS REPORT ON AN INDIVIDUALIZED-INTEGRATED SCIENCE COURSE FOR SENIOR HIGH SCHOOL

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A paper given at the National Science Teachers Association 18th Annual Convention, Cincinnati, Ohio, March 13-17, 1970. This project is sponsored by the Central Minnesota Educational Research and Development Council through an ESEA Title III Grant and by Elk River Independent School District #728.

CENTRAL MINNESOTA COUNCIL

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ERRATA

A number of errors were made by the printers. Some such as leaving the "o" out of astronomy (astrnomy) on page 1 make reading difficult, but do not change the meaning. These have generally been ignored. In two cases corrections have been made by hand. In those cases where the errors alter the meaning in an important way, the corrections are given below:

Page 1, Paragraph 4 under "Brief History" should read: "Two classes, one of fifty-five sophomores and juniors and one of seventeen sophomores and juniors . . ."

Page 10, line 5 at the top: the word five has been omitted. The line should read: " to publishers. The district has received the benefits of five personnel-years of work . . ."

At the bottom of page 10 and continuing on to the top of page 11, seven lines were left out. It should read:

"6. Low ability students seem to thrive under this system.
Note: This refers to low ability--not lack of motivation. However, if the lack of motivation has been caused by years of struggling in a class where the student was always lost, the removal of the cause may remove the symptoms as well, and he will function very well, indeed, in this type of class.
"7. A great deal of learning takes place, especially on the part of some of the students.
Note: This is based largely on teacher judgment . . ."

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INTRODUCTION

The Elk River Science Curriculum Project is developing a three-year science sequence for use in senior high school. The course is designed to be completely individualized. It integrates biology, chemistry, and physics with smaller amounts of the earth-space sciences including: astrnomy, geology, meteorology, oceanography, and space exploration. The project is in its third year of development, and it is now in its second year of tryout in the classroom.

BRIEF HISTORY

The present project grew out of an idea conceived by two teachers in the Elk River, Minnesota, school system, (David Halgren and Donald Olmsted). They submitted a proposal to and received a grant from the Central Minnesota Educational Research and Development Council, St. Cloud, Minnesota, under Title III ESEA.

The first year was spent in preliminary planning and the writing of some material for the course. Additional material was prepared and some techniques for record keeping were developed during the summer of 1968. During the school year of 1968-69 the materials were tried on a pilot class of twenty-five sophmores. These students were of a wide range of abilities and were selected simply on the basis of their willingness to participate in the program and on their parent's permission for their participation.

During the summer of 1969 a five man writing team working for six weeks prepared much additional material.

Two classes, one of fifty-five sophmores and one of seventeen sophmores and juniors, are in the program during this 1969-70 school year.

The soft-ware for the program is described in detail later, but here it should be noted that it has all been prepared by people who are experienced classroom teachers. They include a professor of chemistry and teachers of chemistry, physics, and biology with various amounts of teaching experience ranging from nineteen years to two years and with degrees ranging from PHD's to BS's.

PHILOSOPHY AND GOALS

A number of somewhat unrelated statements might give a clearer picture of the philosophy and goals of the project, than a neater, cleaner paragraph might give.

1. We would like to take the student from where he is and go as far as we can with him in a direction which is most desirable in light of his goals and the goals that he must have if our society (perhaps mankind itself) is to survive.
2. A person can make greater progress if he does not have to wait for others to catch up.
3. One often clarifies his ideas by trying to explain them to others.
4. Sometimes a group can accomplish more for the individuals in the

group than each could accomplish for himself if working alone.

5. Small blocks of material permit greater flexibility than do large blocks of material.

6. Maximum learning will take place if the student is actively involved in the learning process. Sometimes the best role for the teacher is to merely allow learning to take place with the teacher acting as a resources person.

7. Sometimes the division of science into categories such a physics or chemistry serves a useful purpose, but many times it does not. Sometimes this division is a barrier to progress and to learning.

8. The subject matter of science is important, but the actual involvement in living, thinking, and dreaming science is even more impotant.

Perhaps much of the preceding can be summarized into a statement of goals that reads like this:

We want to make it possible for each student, regardless of ability, to proceed at the highest comfortable rate and go as far as possible in attaining a working knowledge of science and an understanding and appreciation of the world in which he lives. We want him to have a knowledge of the problems that mankind is going to have to solve and to have the tools with which to solve them. We want him to have an appreciation of the natural beauty of unspoiled nature and an awesome appreciation of the vast, seemingly endless, universe that is out there to explore. Pragmatically, we also want him to be able to pass his college entrance examination if he is going on to college. There is probably nothing very unique about these goals, but we hope, by means of our project, to come closer to reaching them than is possible in some American classrooms.

THE PRACTICAL ASPECTS--HOW DO OUR CLASSES OPERATE?

I. The Facilities:

Our school is an ordinary, nine-year-old, moderate-sized, overcrowded senior high building. There are more science classes than there are science classroom hours available. Our project should operate more effectively in better facilities, but it can operate very well under conditions that are less than ideal. For our large class (55) we have two rooms that are separated by preparation and supply rooms. One room is a conventional, perimeter-type biology laboratory-classroom and the other is a conventional, combination physics-chemistry laboratory-classroom. Students have free access between the two rooms via the very small (11'x14') preparation rooms. The file cabinets which contain the course materials and the majority of the reference materials and texts are in one of the preparation rooms. This is somewhat less than ideal, but it seems to be the only feasible arrangement possible.

II. Teachers:

From the beginning, an integral part of the program for us has been team teaching. It is perhaps possible for one teacher with a broad major to teach the class, but it is much better to have teachers with depth of training and understanding in each of the fields. Perhaps the ideal would be three teachers, each with a depth of training in one field and a broad knowledge in the other areas.

With team teaching in this program, there are certain advantages. They are:

1. Even if you keep the pupil teacher ratio the same, the probability of having a teacher free and available to render individual help is greater if there are two teachers than if there is just one.
2. The students have a choice as to which teacher they wish to work with at all times. They can base their decision on subject matter, expertise, personality, availability, or any other criteria that they happen to consider important at the moment. We have found that some students, who will work reluctantly, if at all for one teacher, will work willingly for the other.
3. There are two teachers available to observe and solve problems as they arise. This seems to more than just double the problem solving ability. There are problems that can be solved together that neither person could solve individually.

III. The Students:

The students have a wide range of abilities. There are five with special learning disabilities. They attend special education calsses, but they are also in our class. Twenty-three of our students are on the Honor Roll (i.e. they have a "B" average or higher). The remaining forty-four are somewhere in betweeen.

IV. Materials

The heart of the entire program is the Mini-unit. The Mini-unit is a small learning package designed to present concepts to students in a way that is both flexible and efficient. No one level, format, or mode of presentation can accomplish this objective. Each Mini-unit may vary in form from other Mini-units. The Mini-unit is designed to build upon the background that the student possesses and to add new concepts to this store of ideas. This necessitates new approaches in some instances. In some cases the presentation of very basic concepts that have been overlooked in the student's education is necessary. Sometimes, the more traditional or formal materials are what need to be presented.

The Mini-unit facilitates the individualization of instruction by allowing:

1. Great flexibility in the presentation of materials;
2. Variety in the style of materials presented;
3. Various difficulty levels of materials;
4. Individual students learn those concepts that are necessary for them, while other students are learning other concepts;
5. Students to progress at a rate that is determined by their own ability, interest, physical stamina, and motivation.

The concepts are presented by the use of behavioral objectives. In general the Mini-units consist of five parts:

1. A statement of the desired behavioral change.
2. An indication of how to determine that the change has been achieved.
3. Suggested activities and sources needed to bring about the change.
4. Self evaluation of progress and understanding.
5. Some form of evaluation by an instructor is also desirable in some cases.

Many types of Mini-units are possible. Their basic purpose might be categorized as follows:

1. Presentation of specific ideas.
2. Presentation of techniques.
3. Research guides.
4. Summaries or units which bring together previously learned related ideas.

The Mini-unit will vary in style, difficulty level, length, arrangement, and complexity, depending upon the nature of the student for whom it is intended and the nature of the topic that is being presented. There is no "typical" Mini-unit, but each has some, and very rarely all, of these segments:

1. Identifying title
2. Identifying number
3. Objective (Usually stated behaviorally)
4. Prerequisites
5. Introduction
6. Pre-test
7. Pre-test answers
8. Activities
9. References
10. Self Check
11. Answers to Self Check

12. Post-test (Not included with unit)
13. Answers to Post-test (Not included with unit)

The function of most of these parts is obvious from its name, but a few comments are in order. For example, we have two kinds of prerequisites. The first is the normal kind indicated by the word itself. The other is a "helpful" prerequisite. This indicates that its prior completion is not mandatory, but that it will make things easier if it is done before this unit is started.

The introduction is sometimes a brief description of the contents of the Mini-unit. Sometimes it is a motivational section. Sometimes it merely gives background or a reason for the importance of the topic. The Pre-test may serve the function of making it possible for the student to assure himself that, as he suspected, he has already attained the objective of the unit from some past experience. On the other hand, it may be used in the manner of branched programmed learning, to make it possible for the student to determine which aspects of the subject he needs to study and which aspects he can omit. The Self Check enables the student to determine for himself whether or not he has attained his objective. If he has not, he returns to further study and more activities.

V. Records and Grades:

Since the program is individualized, record keeping becomes even more necessary than it would be in a more conventional class. The most important form that is used in our record keeping is the Progress Report that the student fills out when he has completed a Mini-unit. (See the Appendix) There is also another form on which the student reports work which is not directly related to a Mini-unit. He may have become interested in some topic on which we have no prepared material, or he may want to go far beyond the scope of the existing unit. This form enables him to report on his progress while he is working in this area. At present, the material from these two forms is summarized on a cumulative form. However, this arrangement is going to have to be streamlined in order to reduce the expenditure of time and money.

In the first year of the operation within the classroom, we did not give grades. However, we discontinued this practice because neither the students, the parents, or the school board members seemed to care for this procedure. This year we gave the students an option: They could be graded on the basis of S & U (Satisfactory or Unsatisfactory), or they could be graded with the conventional A, B, C, D, F. All except two chose the conventional grades.

The actual grading procedure involves giving the student a sheet listing the criteria for grading (See the Appendix). He puts his name and the grade that he thinks he deserves on the basis of the criteria on the page and returns it to us. Each of the instructors determines a grade for the student on the same basis. The three grades (One from the student and one from each of the two instructors) are then compiled for comparison. If all three are essentially the same, the student gets that grade. If they are different, the instructors discuss the student, his work, and the differences. If they can arrive at an agreement that

the student's own grade is all right, he gets that grade. If the differences cannot be resolved, the student and one or both of the instructors negotiate a grade. Sometimes the student is able to point out why his grade should be higher than the instructors think it should be. Sometimes the student merely agrees that his grade was too high. In any case, when the process is completed, the students knows exactly what grade he is getting, why he is getting it, and what he can do to improve his grade for another time.

DOES IT WORK?

We do not have any objective evidence to prove that our system works at this point. We have started a testing program this year which will give us some objective evidence, but the sesults of the testing will not be available until June.

We have quite a bit of subjective evidence that gives us useful information. The sources of this information are: 1. The students, 2. The principal, 3. Visiting teachers, 4. Visiting supervisors, 5. Parents, and 6. Our own observations and comparisons with past experience.

The principal, who, incidentally, has an ability to analyze a situation and to get information from people, has spent time talking to the students in the absence of the instructors. This was done at the request of the instructors and has been a means of both obtaining favorable comments about the classes and uncovering problems that need to be solved. The students talk freely with teachers and supervisors from other schools that visit our classes. These people in turn can pass the information along to us.

Most of the students seem to like the course. One student, who likes science and is enrolled in both our course and a conventional biology course, told the state science consultant, "This is the only class all year in which I have not fallen asleep." A high ability boy has said, "I like this class. It is easier to go ahead at your own speed. It is easier to go back if you missed something." Another boy said, "I like it very much. If you need help, you can get help quickly. I like the fact that there are two teachers, and you can get help from either. If you are absent, you go right on from where you left off. You haven't missed any important lectures." Another boy said, "It's fun and I like it. I am learning more. You can switch around. You are free to try what you want. This is better than sticking to a book. A book is the same day after day."

When the principal discussed the program with the students actually involved with the class, he got mostly favorable comments. However, they also expressed the need for improvement in certain aspects of the program. Of these suggestions regarding the need for improvement, exactly fifty percent dealt with physical facilities and the problems associated with overcrowding. Only the new building, which will soon be under construction, can solve these problems. Of the fifty percent of the problems not dealing with physical facilities, over half have now been completely solved

and the remainder have been at least partially solved. In some notes to himself (which were not written for publication) the principal wrote:

> "It is interesting to note that of all the negative comments, none were critical of the course approach. All seemed to be interested in ways to improve the course. I left the discussion with an elated feeling toward this kind of instruction. Every criticism was constructive to some degree. There appeared to be no negative attitude about what was taking place. If this kind of attitude continues during the year, we may have an answer to some of our educational problems."

Another indication of the students' reaction to the course is their registration for next year. Sixty-three percent of the sophmores currently enrolled in the course have now registered in the program again next year. Eighty-four percent of the sophmores who are in the class this year are registered for a science class nest year. When one examines the registration forms for the sophmores taking other science courses this year (mostly biology, but one conservation course), he finds that only forty-one per cent are enrolled for science next year. Eighty-four percent retention in science compared to forty-one percent seems to say something that needs saying! It is interesting to note that of the group of integrated science students constituting the sixteen percent who did not register for another science course, forty-three percent put integrated science II down as an alternate choice to be used in case scheduling conflicts prevent their being enrolled in their first-choice courses. The fact that fact that seven of the sophmores who did not take integrated science this year have registered for the course for their junior year is also significant.

When there have been problems, we have tried to solve them. For example, there has been some concern on the part of parents that ~~there~~ their child might not be able to get into college if he did not have a course called biology or chemistry or physics. This was a legitimate concern. We have solved this problem through the manner in which we enter the credit on their permanent record cards. For the good student who is likely to be college bound and who does good work, we will make an entry like this on his records: Integrated Science I (College Prep-Biology Emphasis). Or it could be entered as Chemistry Emphasis or Chemistry and Biology, etc. The entries for other years would be similarly recorded so that, if necessary, the integrated science student could be given credit for physice, chemistry, and biology. We have checked with the University of Minnesota and a School of nursing with strict entrance requirements. Both will accept that notation as credit in the required subject.

The teachers who are teaching the course are pleased with it. They are constantly striving for improvenent, but this is always the case. There are problems, but these are gradually being solved. The good points seem to far outweigh the disadvantages. Good students are learning. Low ability students are learning. Average students are working with materials suited to them and at a rate determined by their own personal abilities and characteristics. Some students need constant prodding; others are always on the go, but the important thing is that both types can function effectively in the same classroom.

It seems safe to make these tentative statements even though one has varying degrees of confidence that they will prove to be correct:

1. Most students like the course.
2. There is an amazing lack of disciplinary problems.
3. Low ability students function very well within the program.
4. Some students progress at a rapid rate with this kind of course.
5. A great deal of learning takes place, especially on the part of some of the students.
6. Some students go beyond the individual Mini-unit and follow up logical extensions of the work started within the unit.
7. Occasionally students will become interested in a topic not covered by a Mini-unit. Our program permits this type of activity which is often very desirable.
8. Students spontaneously form groups for some work; group interaction is not neglected.
9. Groups form, stay together for a while, and then disolve as interests change. This fosters a healthy cross-fertilization of ideas between a wider range of individuals than is possible if "lab partners" are assigned or if each works alone all of the time.
10. Some students need, and in fact desire occasional prodding. In some cases a simple record of his own progress will provide all of the prodding that is necessary. In other cases it takes all of the skill and combined imaginations of both teachers to find ways to encourage the student to work up to his ability.

WHAT IS THE SIGNIFICANCE OF THIS PROJECT FOR YOUR SCHOOL?

There are probably two ways in which this project could be of value to your school:

1. Decide that the plan as outlined is a good plan for your school and adopt it with only slight modifications as soon as it can be done.
2. Adapt and modify some of the ideas and materials presented here to fit your own particular situation. What would you have to do in each case? Some of the problems and procedures for each are outlined below. For more details you will have to contact the author.

I. Adopt the Plan with only Slight Modifications.

A. Facilities: Any facilities in which one teaches could be used, but best results would probably be attained in a building with a very flexible arrangement centered around resource centers.

B. Teachers: You will need good teachers with depth in their field, a belief in the individual, and a willingness to work.

C. The materials that we use cannot be purchased in ready-to-use form. If you have a <u>real need</u> and <u>desire</u> for the materials and <u>money</u> with which to <u>reproduce</u> them, see the author of this paper. It is, of course, possible to have your teachers write their own

materials and, if you have money and are in no hurry, this may be a good course to follow because of the professional growth that would take place in your faculty.

II. Adapt and Modify.
Most of the questions you would need answered are answered under (I) above.

WHAT HAS THE PROJECT COST ELK RIVER SCHOOL DISTRICT #728?

Because the project was started and has operated with federal funds, the cost to the District up to July 1, 1969 was very slight. The district's contribution consisted mostly of office space, the use of the school's mimeograph machines, etc. However, in 1969 the District #728 Board agreed to help support the project to the extent of about $15,000. This money was used largely to pay one teacher-writer, a summer writing team, a half time secretary, and to purchase some supplies. In addition, the district is also furnishing new and very adequate office space.

At this point, it is not known what support the school board will give the project in 1970-71. It is known that there will not be any more federal funds available. It is hoped that the district will be willing to expend about another $20,000 on the project. This will put it in such a form that any additional modifications can be done by the teachers on their own time. This additional $20,000 would be used for another summer writing team, summer secretaries to reproduce the materials written, paper, stencils and other supplies, a half-time clerk typist, and two-fifths time for two teachers to enable them to continue to write and revise materials during the school year.

WHAT HAS ELK RIVER SCHOOL DISTRICT #728 GAINED FROM THE PROJECT ?

The impact of this project on the school district is obvious to anyone who cares to investigate. There is, first of all, the project itself and its classes. This will be discussed more thoroughly in later paragraphs. The other science classes are differen, and we hope better, because of the project. The math department is developing an individualized program for their classes. They are using their material for the first time in their classes this year. The English and social studies departments are also working on curriculum modification and studying the ideas of individualization. Woek on individualization of instruction and curriculum improvement is going on in the junior high and elementary system. Personnel from the project have been active in assisting the other subject matter areas and other schools of the district when asked to do so.

The most obvious gain, of course, is in connection with the project itself. Every science teacher in the senior high and some in the junior high have worked on the project and have benefited from the resulting professional growth.

There are about 600 Mini-units being used by the students in the project. In addition, there is a wide variety of resource materials in use in the classes. This material has been collected through many hours of searching through displays at meetings and conventions and through countless letters to publishers. The district has received the benefits of personnel-years of work by teachers, writers, curriculum consultants, and project directors without cost to the district. There is also a certain amount of equipment which will become property of the district.

Another small but important benefit is the visitors from other schools and even from other states that the project has attracted. These people come to learn about the project and to observe the classes. In the process there is the usual interchange of ideas, and sometimes the visitors are able to lend the fresh insight which is just what is needed to solve a problem.

In summary, it might be safe to say that Elk River has a good school board, good administrators, and good teachers and the project has helped to catalyze a reaction which has helped to make the school more vital and alive. Of course, with those first three ingredients, it would be vital and alive anyway, but we feel that the project has helped to make it better.

SUMMARY AND CONCLUSIONS

The Elk River Science Curriculum Project is developing a three year integrated-individualized science course for senior high school. Students may enroll in the course for one, two, or three years. In the course they can study biology, chemistry, and physics. They can progress at their own rate and (within limits) can design their own course from the materials available.

THE FOLLOWING TENTATIVE CONCLUSIONS SEEM JUSTIFIED:

1. Many students like this kind of course and function well within it.
2. Given the opportunity, many students are able to effectively plan and organize their own activities within the classroom.
3. Students with an interest in a particular topic can go far beyond what they would ordinarily be able to learn in the classroom.
4. It is probably possible for a smaller school to offer advanced biology, chemistry, and physics through their integrated science classes.
   NOTE: This has not been tested by us as yet, but we intend to do this in 1970-71.
5. A few students do not seem to be able to develop the necessary self-discipline to make themselves work in the free atmosphere of a class like this. We hope that this in an indictment of previous lock-step education rather than of our project, but in the meantime, it has to be faced as reality. This may also be a factor aggravated by large class size.
6. Low ability students seem to thrive under this system.

NOTE: This is based largely on teacher judgement, but since this judgement is backed by twenty-two years of combined experience it should probably not be ignored. In June we will have more objective evidence as to the correctness of our conclusion.

8. The fact that the teachers feel that they are fulfilling their purpose when they are teaching this class is a recommendation for it.
   NOTE: The teachers feel exhausted, but good, after teaching the classes.
9. The course or some modification of it seems very much worthy of consideration by other school systems.

APPENDIX

Contents

Abstract: A Progress Report on an Individualized-Integrated Science Course for Senior High School

Progress Report Form (for Mini-units)

Progress Report Form (for work not directly related to Mini-units)

Cumulative Record for an Individual

Sheet titled "Integrated Science", stating the factors which affect the letter grade received for students in integrated science.

A Complete Mini-unit: "Writing a Mini-unit, Professional Edition"

A Progress Report on an Individualized-Integrated Science Course for Senior High School

The more nearly we approach the ideal of helping each person learn in a manner which is most suited to him as an individual, the greater the learning efficiency will be. The Elk River Science Curriculum Project is an attempt to produce a course in which each individual is considered as an individual and to design a course specificially for him. At the same time, the project faces reality in regard to class load, restricted physical facilities, and finances.

Now in its second year of operation, the course specificially presents material in small packets called Mini-units. Each Mini-unit includes an objective specifying the behavioral change or goal that the student is to achieve and suggested activities, experiments, readings, problems, visual aids, and tests to help in the achievement. Students are encouraged to go beyond the specific suggestions and, if desirable, to depart from the prepared materials completely for a time.

Certain advantages can be claimed for the program: 1) great flexibility is possible; 2) although special facilities would be helpful, the program will operate very well with capable and energetic teachers in a conventional building; 3) students assist in the design and operation of a course especially suited to their needs and capabilities. They proceed at a rate which is determined by their own interest, ability, and motivation; 4) students need not re-study familiar material; and 5) it is possible to stress the science with all that that implies rather than just subject matter.

A testing program has been instituted to compare the progress of students in the experimental classes with those in more conventional physics, biology, and chemistry classes in such categories as knowledge, comprehension, application, and analysis and evaluation.

We feel that the program is meritorious and worthy of consideration by other educators.

PROGRESS REPORT Name_____ Mini-unit #13._____ _____ 00 _____ _____ _____

Title of Mini-unit_____

Started_____ Work Completed_____ Total time required_____
(date) (date) (in hours)

Please answer the following questions by placing an "X" in the square if the answer is yes. A blank square means that the answer is no.

A. Did you need help? ☐ If you check this square, do "B" to explain the kind of help you needed and who helped you, otherwise go on to "C".

		I got help from:	Teacher	Other Students	Parents
B. I needed the written material explained.	☐		☐	☐	☐
I needed help to find the reference material	☐		☐	☐	☐
I needed some other kind of help	☐		☐	☐	☐

Please indicate the kind of help you needed:_____

_____

C. Was there a self check? ☐ Did you do it? ☐ Was it helpful in letting you know how you were doing? ☐ Did you go back and do more work after doing the self check ☐

Please write your reaction to this mini-unit. _____

_____

_____

Decide what mini-unit you are going to work on next if you can, and put its number here:
13. _____ _____ 00 _____ _____ _____.

(Space below this line is for teacher's comments)

Satisfactory _____ Comments:

Minimal _____

Instructors initials_____

PROGRESS REPORT Name_____ Note: This report is for work not directly related to a specific Mini-unit.

The Nature of the Work (What have you been doing?)_____

_____

_____

Started _____ Work Completed _____ Total time required _____
(date) (date) (in hours)

What got you started on this project?_____

_____

What have you learned from it?_____

_____

_____

_____

_____

_____Use the back of this page for additional space if necessary.

Would you recommend that a similar activity be written up as a Mini-unit so that others can benefit from the same experience?_____ Why?_____
(Yes or No)

Decide what Mini-unit you are going to work on next if you can, and put its number here:
13. _____ _____ 00 _____ _____ _____

_____
(Space below this line is for teacher's comments.)

Comments: Instructor's Initials_____

Cumulative Record For _____ Year___ ___ Page___

Mini-unit Number	Title of Mini-unit	Date Started	Days Worked	Instructor's Comments
13.___.___00___ ___ ___		___/___	_____	_____
13.___.___00___ ___ ___		___/___	_____	_____
13.___.___00___ ___ ___		___/___	_____	_____
13.___.___00___ ___ ___		___/___	_____	_____
13.___.___00___ ___ ___		___/___	_____	_____
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INTEGRATED SCIENCE

Factors which affect the selection of a letter grade for students in integrated science:

1. Production--how much is actually accomplished.
2. Quality with respect to ability.
3. Consideration for others when they are working.
4. General attitude toward learning.
5. Care of equipment.

Other factors that might affect the grade:

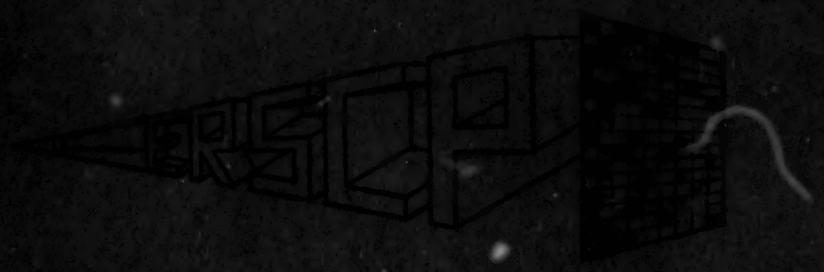
1. Evidence of outstanding scientific approach.
2. Cooperation with instructors.

Fleming--Scribner

PROFESSIONAL EDITION

WRITING A MINI-UNIT

Elk River
Science Curriculum Project



OBJECTIVE

To be able to write a Mini-unit which would be satisfactory for use in a senior high science class. Satisfactoriness will be determined by two judges using the criteria listed at the end of this Mini-unit.

CENTRAL MINNESOTA COUNCIL
531 LINCOLN AVENUE SOUTHEAST
ST. CLOUD, MINNESOTA

COOPERATION FOR BETTER EDUCATION

INTRODUCTION

The mini-unit is a small learning package designed to present concepts to students in a way that is both flexible and efficient. No one level, format or mode of presentation can accomplish this objective. Each Mini-unit may vary in form from other Mini-units.

The Mini-unit is designed to build upon the background that a students possesses and to add new concepts to this store of ideas. This necessitates new approaches in some instances. In some cases the presentation of very basic concepts that have been overlooked in the student's education is necessary. Sometimes the more traditional or formal materials are what need to be presented.

The Mini-unit facilitates the individualization of instruction by allowing:

1. Great flexibility in the presentation of materials.
2. Variety in the style of materials presented.
3. Various difficulty levels of materials.
4. Individual students to learn those concepts that are necessary for them, while other students are learning other concepts.
5. Students to progress at a rate that is determined by their own ability, interest, physical stamina, and motivation.

The concepts are presented by the use of behavioral objectives.

In general the Mini-units consist of four parts:

1. A statement of the desired behavioral change.
2. An indication of how to determine that the change has been achieved.
3. Suggested activities and sources needed to bring about the change.
4. Self evaluation of progress or understanding.
5. Some form of evaluation by an instructor is also desirable in some cases.

Many types of Mini-units are possible. Their basic purpose might be categorized as follows:

1. Presentation of specific ideas.
2. Presentation of techniques.
3. Research guides.
4. Summaries or units which bring together previously learned related ideas.

OBJECTIVE: To be able to write a behavioral objective which would indicate a behavioral change which would be desirable and appropriate for accomplishment in a senior high science class. Satisfactoriness will be determined by two judges using the criteria listed in Activity I.

In general a behavioral objective is a statement specifying a behavioral change and a means of determining wheter or not that change has taken place. Mager gets even more specific and says that the behavioral objective should specify: 1. The behavior that is desired, 2. The conditions under which the behavior will be exhibited, and 3. The level of performance required. We will examine each of these separately:

I. The Behavior that is Desired

Examples: THE STUDENT WILL BE ABLE TO MAKE A SMOOTH 90 DEGREE BEND IN GLASS. . .

THE STUDENT WILL BE ABLE TO LIST FIVE OF THE MOST IMPORTANT PARTS OF A PLANT CELL. . .

THE STUDENT WILL BE ABLE TO TRACE THE CHANGES IN FORMS OF ENERGY FROM THE LIGHT ENERGY OF THE CLASSROOM LIGHTS BACK THROUGH THE ELECTRICAL ENERGY ETC. TO THE ULTIMATE SOURCE OF THE ENERGY. . .

II. The Conditions Under Which The Behavior Will Be Exhibited

Examples: GIVEN A BUNSEN BURNER WITH A FLAME SPREADER, the student will be able to make a smooth 90 degree bend in a 30 centimeter LONG PIECE OF SMALL DIAMETER GLASS TUBING. . .

2. The student will be able to list FROM MEMORY five of the most important parts of a plant cell. THE LIST CAN BE GIVEN ORALLY OR IN WRITING. . .
3. The student will be able to trace the changes in energy forms from the light energy of the classroom lights back through electrical energy etc. to the ultimate source of most energy on earth, namely the sun. HE WILL DO THIS WITHOUT THE AID OF ANY REFERENCE MATERIAL OR NOTES. . . THE RESULTS CAN BE IN THE FORM OF A LIST OF FORMS OF ENERGY.

III. The Level of Performance Required

Examples:

1. Given a bunsen burner with a flame spreader, the student will be able to make a smooth 90 degree bend in a 30 cm. long piece of small diameter glass tubing. TWO OUT OF FOUR ATTEMPTS WILL BE SATISFACTORY (THAT IS THEY WILL NOT REDUCE THE DIAMETER OF THE TUBE BY MORE THAN TWENTY PERCENT AND THE BEND WILL NOT TAKE UP LESS THAN FOUR NOR MORE THAN TEN CENTIMETERS OF THE LENGTH OF THE TUBE.)

2. The student will be able to list from memory five of the most important parts of a plant cell. The list can be given orally or in writing. ALL FIVE MUST BE AMONG THOSE LISTED FOR STUDY IN THIS MINI-UNIT AND THE SPELLING MUST BE CORRECT ENOUGH SO THAT THE WORDS ARE EASILY RECOGNIZABLE.

3. The student will be able to trace the changes in energy forms from the light energy of the classroom lights back through electrical energy etc. to the ultimate source of most energy on earth, namely the sun. He will do this without the aid of any reference material or notes. The results can be in the form of a list of forms of energy. THE LIST MUST BE COMPLETE, IN THE PROPER ORDER, AND CORRECT FOR LOCAL GENERATING FACILITIES.

ACTIVITY I

Write two behavioral objectives. Discuss them with a fellow student. Revise them if necessary. Discuss and revise again if necessary. Present them to your instructor for comment unless instructed to do otherwise.

Criteria for Judging your Behavioral Objectives

1. Is the desired behavior specified?
2. Are the conditions under which the behavior is to be exhibited specified?
3. Is the required level of performance specified?
4. Is the objective suitable for a senior high science class?

OBJECTIVE: To be able to write that part of a Mini-unit which suggest activities, audio and visual aids, and references which will be useful in producing the behavioral change indicated.

ACTIVITY II

Write that portion of the Mini-unit mentioned in the objective above for one of your performance (behavioral) objectives. Use the references listed below and any others that you can think of as needed.

Reference

"Sound and the Ear"

A sample Mini-unit

Elk River Science Curriculum Project

Comments

Remember that this is just one sample. Many different approaches are possible and the techniques employed and the arrangement used will vary with the task being accomplished.

ACTIVITY II (Continued)

"Chemical Nomenclature"

A sample Mini-unit from the

Elk River Science Curriculum Project

Notice the difference between this and the previous reference. This one has a Self Check, so that the student can evaluate his own progress. It also suggests supplementary reading so that he can delve more deeply into the topic if he wishes.

"Atomic Words"

A sample Mini-unit from the

Elk River Science Curriculum Project

Note that the performance required is not spelled out in the objective. However, we consider the entire Mini-unit to be a part of the objective in a sense, and therefore the Self Check helps to define what performance is expected.

Text books and laboratory manuals

from your particular subject area

Sometimes it is necessary to write your own material but most often someone has already done a good job of it for you. Different texts present ideas from different points of view and at different difficulty levels. Choose those that are appropriate for the group for which you are writing.

Film loop, film strip, and 16mm

motion picture catalogs

These can be valuable, but remember that only those actually available to the student at the time that he is doing the Mini-unit will be of any use to him. If the school does not have its own film library or one that is accessible on very short notice, the inclusion of a 16 mm motion picture film may be impractical.

Your own imagination, creativity

and experience

This is probably the best reference of all.

Some general Statements

1. Whenever possible there should be activity--that is things for the students to do. These might be experiments, practice of techniques. Things that might be done as a demonstration in an ordinary classroom, and simple activities that illustrate a point but would hardly be called an experiment.

2. The difficulty of the activities and references should reflect the ability of the students for which the Mini-unit is intended.

3. The nature of the topic or the behavior change will often influence the nature of the activity and the difficulty level of the reference material (e.g. A student who experiences extreme learning difficulties would ordinarily have little use for Einstein's General Theory of Relativity) and so it would not really be necessary to try to find extremely "easy" materials when preparing a Mini-unit on this topic.

4. The material presented should help in attaining the objective. (e.g. If the student is learning a technique, he must be shown the technique and given the opportunity for practice.)

5. The degree of specificity required will depend upon the intelligence and the experience of the student.

OBJECTIVE: To be able to write that part of the Mini-unit which helps the student to determine whether or not he has achieved the objective of the Mini-unit.

INTRODUCTION

Sometimes the success is self evident. This would most often be the case in Mini-units involving techniques. For example: Whether or not he has succeeded should be rather obvious to a student if his objective was to master the technique of boiling 10 ml of water in a 50 ml test tube without having the water boil up and out of the tube.

On the other hand success is not quite so obvious with something as complex as writing a Mini-unit.

The need and desirability of some separate means by which the student can check on his progress will depend upon the nature of the objective and the content of the Mini-unit.

ACTIVITY III

Decide whether or not some form of self check is desirable for your Mini-unit. If it is write one. The three sample Mini-units might be helpful. Remember that you are trying to help the student to determine if he has accomplished the OBJECTIVE. If the questions are not related to that, they are not suitable. For example, if your objective were to have the student be able to use the Periodic Chart of the Elements to determine the atomic weight of the elements, if given the symbol for the element, it is not legitimate to ask him to use the Chart to determine the atomic weight of <u>Iron</u> unless you give him the symbol <u>Fe</u> or unless he is supposed to have memorized the Iron-Fe combination in some Prerequisite Mini-unit.

A Check on Your Progress

The best way to check on your progress to date is to have a fellow student look over your work and discuss anything that does not seem right to him. He may also be able to suggest simple cahanges or additions that will result in an over all improvement.

OBJECTIVE: To be able to devise a means of determining whether or not the objective of the Mini-unit has been achieved.

It may seem that the self check takes care of this matter. It may, but the emphasis here is slightly different. Here we are concerned with the instructor determining whether or not the objective has been achieved. In the self check we were concerned with making it possible for the student to determine whether or not he has completed his task and reached his goal. In some cases the self check or a different form of it might serve the instructor's purpose very well. In another case the instructor might look at the bent glass produced by the student and thus visually determine the degree of success.

ACTIVITY IV

Decide upon a suitable means of determining successful achievement of the objective and write the necessary test or prepare the necessary instructions. This may well be a separate part that would not be attached directly to the Mini-unit.

Final Summary and Criteria for Judging the Finished Product

1. Does it have a behavioral objective?
2. Does the behavioral objective meet the criteria for behavioral objectives listed in Activity I of this Mini-unit(about Page 3)?
3. Is the objective suitable for achieving in a senior high school science class?
4. Does the Mini-unit contain activities, experiments, and references which will assist the student in achieving the objective?
   a. Are the activities etc. of a suitable level of difficulty for the type of individual for which it was intended?
   b. Will the activities etc. be likely to serve their purpose?
5. Does the Mini-unit provide for self evaluation if this is desirable?
6. Is a means provided for determining whether or not the student has indeed achieved his objective as indicated in the behavioral objective?
7. Would the Mini-unit be likely to turn the student on or off? You may wonder if this question is a legitimate question. It <u>is</u> because the objective of **THIS** Mini-unit was that you were to write a "satisfactory" Mini-unit. The question is not "kosher" in that the Satisfactoriness "is to be judged by two judges using the criteria listed at the end of this Mini-unit" and in htat sense the student's reaction does not enter into the decision. However, <u>it is an important question to ask</u> about each and every Mini-unit that you write.